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Measures for increasing demand of solar energy

Valentinas Klevas*, Lina Murauskaite, Audrone Kleviene, Eugenijus Perednis

Lithuanian Energy Institute, Breslaujos str. 3, LT-44403 Kaunas, Lithuania

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ABSTRACT

Renewable energy sources (RES) will have to play the main role in moving towards sustainable economic development. Talking about the perspectives of the use of solar energy, it is evident that the main market is decided by the consumer. The most important problem, determining the slow absorption process of solar energy on the part of the consumer, is the lack of knowledge and organisation, deterrent amount of investments, and especially the differences between energy suppliers and users in the heating sector. The main focus of the research is what conditions are needed for heat energy that is produced by users on the basis of solar technology and how it would be able to compete with other energy sources. District heating (DH) may be appropriate infrastructure to implement RES technologies both on production and demand side due to the simultaneous production of heat and electricity in combined heat and power generation plants. Conclusions have been made concerning the scale and assumptions of how solar technologies may be competitive.

Contents

1. Introduction

Implementation of RES technologies is restricted by slow demand rates. The main problem is not only high initial capital costs, but also measuring of public interest, which is not included in market transactions. Public interest is expressed not only directly through the continuous supply of energy resources in the future, and the solving of social and environmental problems, but also through the implementation of EU Directives.

Integration of RES may be more successful after reliable methodological assessment of the positive effect for solving social, economic, and rural development problems in regional development context.

However, the nature of RES determines that their usage is the most appropriate to the consumer. In most cases, with rare exceptions, the utilisation of RES is possible only as a part with other energy resources. The worst of it is that different options are being compared as if every type of fuel would be able to provide the entire volume of supply. In this regard biofuel is in a

* Corresponding author. Tel.: +370 37 40 19 36; fax: +370 37 35 12 71.
E-mail address: klevas@mail.lei.lt (V. Klevas).

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preeminent position, while it is relatively cheaper. Nevertheless, the substantial increase in demand of limited resources raises the price: it is the expression of the law of demand and supply, which cannot be transformed with any strategies or plans. On the other hand, biofuel is the product of the economic activity and its renewal depends on the extent of the activity.

District heating (DH) technology is a promising tool for implementing RES technologies on the demand side and consequently achieving energy and environment policy goals. DH has various advantages compared to individual heating systems. It is usually more energy efficient due to the simultaneous production of heat and electricity in combined heat and power generation plants. However, DH is less attractive for areas with low population densities. The importance of DH in EU would justify a more intensive use of RES applied to this type of heating system, and must be considered in the design of energy policies [1].

General characteristics of Lithuanian DH sector—its high heat market share, especially in big cities—indicate a strong position and therefore the important role in cities' energy supply. Although DH systems were developed in the planned economy, they were not always grounded economically, and networks in many cases were shortened after disconnections of collapsed industries. Initially designed pipes appeared oversized and then resulted in high heat losses. Bearing in mind general European energy policy strategy and targets, it is evident that DH technology in Lithuania will remain as the main technology supplying energy to buildings in large cities and towns [2].

2. The significance of district heating as infrastructure for promotion of RES demand

The encouragement of energy producers and consumers for efficient use of RES is the major goal of energy policy, as regulated by the Energy Law of the Republic of Lithuania and National Energy Strategy. Promotion of local and RES usage and energy efficiency are established in the Energy Law of the Republic of Lithuania as priority objectives of the energy sector regulation. Seeking to promote the use of RES, the Ministry of Economy has issued an order regulating energy purchase.

As IEA [3] recently pointed out, RES will have to play a central role in moving the world towards a more secure, reliable and sustainable energy path. The greatest scope for increasing the use of RES in absolute terms lies in the power sector. Although RES are expected to become increasingly competitive as fossil-fuel prices rise and renewable technologies mature, the scale of government support is set to expand as their contribution to the global energy mix increases. The important role gains national and international regulation of RES.

The European Union is one of the most active developers of RES promotion methods and assurance measures. Its initiatives expressed in the Directives to increase the percentage of renewable energy resource in the common energy balance up to 20%, to reduce energy consumption by 20%, and to reduce greenhouse gas emissions by 20% up to 2020 would lead to a drastic reduction of EU energy dependence on import [4].

Most experience in supporting RES is offered to the electricity sector. The EU Directive 2001/77/EC required member states to increase the share of RES in the electricity sector using national support instruments. **In contrast, no legislative framework at EU level was available in the heating sector before the Directive 2009/28/EC** [5] **was implemented**. Later, following the implementation of Directive 2009/28/EC, every member state has developed its own National Action Plan that determines specific objectives for each member state in the use of RES for each sector, including heating.

Major changes appeared with the introduction of new energy policy goals by adopting the RES Directive (Directive 2009/28/EC), where DH is recognised as a promising technique for reaching overall strategic energy goals: safety of energy supply by increasing independence from imported energy resources, wider use of waste energy from industries and integration of RES into energy supply infrastructures. Article 4 of the RES Directive required member states to submit National renewable energy action plans by 30 June, 2010. These plans provide detailed roadmaps of how each member state expects to reach its legally binding target for 2020 for the share of renewable energy in their final energy consumption.

Necessary preparations are conducted in all EU countries by implementing this Directive. The forecasts of Lithuania reveal that biomass is the main opportunity for implementation of these plans by 2020 (Table 1).

It should be noted that the attention given to the potential of solar and geothermal energy is inadequately small. **Solar energy** is a very important RES. However, it is assumed that economic potential of solar energy in Lithuania is rather limited due to its expensive technology and unsuitable climatic conditions. On the other hand, this approach is not entirely justified, because in Lithuania the annual average solar energy is about 1000 kWh/m^2, while in southern Germany – 1260 kWh/m^2, and in northern Germany – 970 kWh/m^2, which means that the climatic conditions for solar energy in Lithuania are similar [6].

The analysis of RES use dynamics in Lithuania revealed that Lithuania has a relatively high RES potential. The main RES is biomass. However, alternative energy sources are not used sufficiently. In order to increase the usage of RES in Lithuania and to pursue the obligations to EU, it is essential to determine the causes that influence slow development of renewable energy and to identify the main RES utilisation problems.

The major part of RES that is used to generate energy in DH sector consists of wood biomass. It is essential to increase the collection of logging residues and to improve the technologies of growing energy crops by substantially expanding the use of

Table 1
Projection of RES in Lithuania (2009–2020) [7].

RES	2009 (ktoe)	2009 (%)	2020 (ktoe)	2020 (%)
Solar energy	0	0	1	0
Wind	14	2	99	5
Hydro energy	37	4	59	3
Biofuel	53	6	188	9
Geothermal	5	1	20	1
Biomass	763	88	1626	82
Total	872	100	1993	100

Table 2
Dwellings by type of hot water supply (% of all dwellings) [8].

	Total	Urban area	Rural area
Centralised hot water supply from the city/town (district) heating system	50.2	71.3	2.5
Centralised hot water supply from a local boiler	1.6	2.1	0.6
Individual hot water supply	31.2	20.4	55.8
No hot water supply	17.8	7.2	41.6

biomass resources. However, there are different opinions: the resources of biofuel are limited locally; the major part of costs consists of the collection and preparation of biofuel for use. Wood is used as biofuel, usually of the kind that is suitable for the construction and the production of furniture, and the price of this resource is rising because of the competition. The cost of the collection and preparation of non-merchantable wood is exceptionally high. It is illustrated by the fact that currently a large amount of non-merchantable wood is accumulated, because it is considerably cheaper to make chips from logging than to handle, bundle and transport the residue of logging.

The use of RES for DH could be implemented by decentralising the production of heat, solving the problems of independent heat producer's connection to DH networks, adjusting the purchase of heat energy that is made from RES and by other measures to promote the use of RES for the production of thermal energy.

One of the analysed possibilities is the use of solar energy for the preparation of hot water in apartment buildings. The state supports (in accordance with the procedure where the government compensates 15% of investments) the measures for energy efficiency improvement according to the Programme for renovation/upgrading of multi-apartment buildings. The funding of RES (solar, wind, etc.) mechanisms is also included. In the future there is a chance that in newly constructed houses there will be solar collectors for the preparation of hot water and they will use heat provided by the sun. If there is financial potential, anyone can install solar collectors. Furthermore, the other reasons are to protect the environment and to use RES and to do something new and unusual in life. Nowadays the main and determining factor for the decision of the use of solar energy for preparing hot water is limited financial resources.

Solar collectors can be installed on the roof of the building, fixed to a wall or assembled on the ground. It is important that the biggest possible amounts of solar radiation would reach the surface of a solar collector. Table 2 shows that 50.2% of all households are centrally provided with hot water from the city (district) heating network (city 71.3%, village 2.5%) and 1.6% are centrally provided from the local boiler-room (city 2.17% and village 0.6%).

As indicated in the Lithuanian National Renewable Energy Action Plan, the National Strategy for the Development of Renewable Energy Sources, among other priorities of the development of energy from RES, envisages utilisation of the existing DH infrastructure and further development of necessary infrastructure while creating conditions for the development of RES. It is predicted that biofuel to be consumed in the DH sector should become the biggest contributor to the increase in the consumption of RES. Taking into account technological possibilities of the DH sector and economic advantage, heat production from RES in this sector should be increased by no less than 60% by 2020.

A wider use of renewable energy enables diversification of energy supply and meeting the goals of sustainable development. An overview of the present Lithuanian and EU legal regulation of the use of RES highlighted that the promotion of use of RES is among Lithuanian energy policy priorities.

It can be stated that the potential of the use of solar energy could be considerably larger in households that are in the area of the DH system.

3. Methodological justification of RES demand support measures on the example of solar energy

3.1. Evaluation of the RES efficiency in the context of sustainable development

Transition economies, especially Lithuania and other Baltic states, are positively disposed to the promotion of RES. Many countries view renewables as a way of promoting the development of small and local businesses in selected areas and diversifying supply patterns at the regional level. RES (including biomass, solar, wind, geothermal and hydropower) have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases. In addition, the greenhouse gas abatement due to a more intensive use of RES would contribute to the achievement of the EU target, which is related to climate change, this being the fourth target in its energy strategy [1].

However, integration of sustainable energy projects, e.g. RES technologies, may be successful after reliable methodological assessment of positive effect of such projects for solving social, economic, and rural development problems in the context of regional development. The scientific issue is to define the economic background for policies and measures aiming at sustainable energy development [9].

Most investors, while choosing places for their investments, usually analyse strategic plans and these are critical factors for choosing a place for investments or at least choosing possible variants.

The need to support RES is defined by the shortcomings of the market, which create unequal conditions for comparability and competitiveness of various types of fuel and energy.

There are several reasons why in our country, as in many other countries, solar energy is used distantly. We hypothesise that the current situation exists not just because of the lack of economic support. The more significant reasons are lack of organisation, gaps of public education and dissemination of knowledge in society, and also too high expectations of getting the support from the state. Generally it is operated on standard opinions that are partially right, but more important factors, which vary in time, are not considered. Knowledge is usually concentrated and presented in a narrow approach, when some facts are emphasised and some are suppressed. For example, it is assumed that economic potential of energy made from solar thermal energy is poor because of the expensive technologies and inappropriate climatic conditions. This fact is easily denied by the countries with similar climatic conditions, where the development of solar energy is vigorously and rapidly increasing next to other types of RES.

A breakthrough is noticed even in Lithuania in 2008–2011, especially after the feed-in tariffs for the electricity, produced in solar power plants and supplied to networks, were announced. Also there are many examples that even without the high support from state numbers of consumers install solar energy devices. However, these facts are outside the official statistics yet.

The opportunity of the use of solar energy and the potentially huge consumer market are not getting enough attention in the Government documents. Therefore, so that this type of energy would be used more in Lithuania, effective support from the Government forming the basis for a competitive solar energy price is necessary. However, the support does not have to be in direct subsidies or other financing forms that are paid from budget or by consumers. “Cheapness” or “expensiveness” is more psychological, varying in time concept. Moreover, both cheapness and expensiveness are temporary conceptions that strongly depend on the extent of technology implementation. For example, in Europe an evident trend of decreasing costs of solar hot water systems is observed. The price decreased by 40% from 1995 to 2006 and reached about 870–1015 €/kW; the forecast is that the price will drop to 435–465 €/kW by 2025. Prices in Lithuania are about 725–900 €/kW at the moment.

The other standard opinion is about the “cheapness” of biofuel, which seemingly should rescue the heat sector. The prime cost of the heat increased about 30% in all municipalities (except of Lazdijai) in the last decade. It is maintained that this increase

of price was determined by the rises in cost of fuel (the price of natural gas was 104 €/toe in 2000 and 368 €/toe in 2010; the price of fuel oil was 132 €/toe in 2000 and 329 €/toe in 2010; the cost of biofuel was 51 €/toe in 2000 and 181 €/toe in 2010) [10]. As the authors state in the same paper, the increase of biofuel prices and the unification of prices in all Baltic and Northern countries indicate that this type of fuel is transported in longer distance, and the transportation costs form increasingly smaller part of the final cost, when the prices of sold fuel are increasing. In the market of Lithuania the prices of wood fuel are similar to the prices in neighbour states, and biofuel becomes the product of the regional market. Unfortunately, it has to be admitted that there is a one direction movement – to the Scandinavian countries.

From the point of view of RES supply support tools for technology creators and suppliers mean compensation of social RES production costs as traditional resources are not evaluated correctly because of market errors.

From the approach to RES demand one should investigate correct evaluation of social benefits, which may show those advantages, which are not seen in investment solutions, e.g. inexhaustibility and possibility to ensure energy resources for future generations. RES is a wide group of energy resources, and the assessment of these resources depends on the potential, secure and sufficient supply, environmental and renewable character, as well as the impact on solution of social problems.

As some RES technologies, e.g. solar energy, also solve environmental problems, they can be additionally funded from other sources.

The background of the research is the following conceptual statements:

- The support of state and private market participants to RES business is considered as correction of market shortcomings to solve sustainable development problems.
- Prices of all energy resources must be based on social costs with the assumption that it is methodologically possible to justify all aspects in the use of fuel and energy – security, environmental, social, and renewability.
- RES benefit can be assessed according to real benefit now and in the future, which is not fixed in investment efficiency with the assumption that various sustainability criteria may have a single denominator on single methodological background.
- Justification of RES support measures is based on the comparison of fuel and energy resources used by the energy system, on competitive ability while assessing various sustainable development aspects by a single criterion.
- RES competitive ability is evaluated not in general approach, but in specific territorial environment till a certain optimal level, where marginal costs and marginal benefit of all types of energy become equal.

With regard to the definition of the guidelines for sustainable energy development in economic understanding, firstly we should clearly evaluate current or necessary infrastructure, related to the used type of fuel.

The economic theory explains the main reason why there is not enough demand in the market for some products and services, although they are very beneficial for the society. The reason is that the external benefit of the product or service generally is not included in the direct market operations and in prices [11]. It is a particularly important moment in terms of RES. Demand of RES technologies does not indicate the benefit of the society (social benefit), which is gained by using the energy produced from RES. The benefit is dispersed between different users which can be people, future generations, cities, and companies. People, even if they do not participate in the market transactions, sometimes can

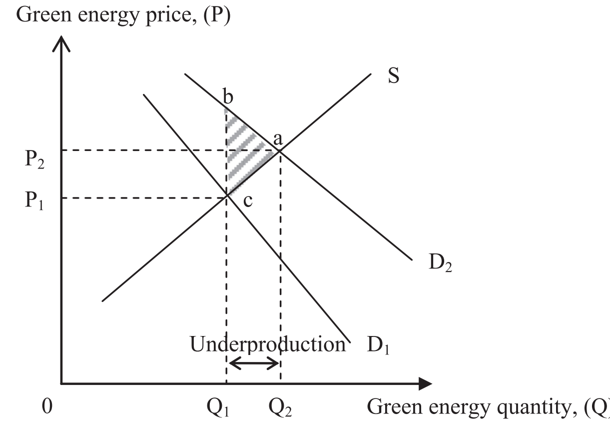

Fig. 1. Probable influence of external benefit evaluation on RES demand.

get some product benefit for free. The external environmental benefit of using RES is probably the best example of external benefit. Therefore due to the RES use for energy production, the negative environmental influence is being reduced, organic fuel resources are being economised, new technologies are being installed, etc. Fig. 1 shows the “green” (made from renewable energy resources) curve of electricity supply S, that involves the expenditures of producing the “green” energy. The main expenditures cover machinery and equipment, new technologies, employee's wages and other expenditures for the training of staff, qualification improvement courses, etc.

If the benefit from the “green” energy consumption is unknown or unvalued, consumers will choose the volume of purchased energy by the demand curve D_1. The “green” electricity will be bought in smaller amounts than would be economically reasonable: quantity Q_1 instead of Q_2. However, when buying the “green” energy made of RES it reduces the pollution to all residents. Everybody avoids diseases and other negative consequences that emerge from the polluted environment. This benefit is not included in demand D_1. The curve of demand should be D_2, where the external benefit is evaluated. The main problem is to include the benefit into the expression of economic indexes.

Marginal benefit of every additional unit of electricity from the quantity of Q_1 to Q_2 exceeds their marginal production costs. External benefit that is shown in the triangle “abc” is not realized and represents the inefficiency of the market. We note that the benefit is known and declared, but this knowledge is not converted to concrete practical calculating mechanisms. However, conclusive calculations are not enough. It is necessary to significantly increase structural changes in order to initiate the process of RES development. Especially important is that knowledge becomes the main driving force of this process.

Without the state intervention competitive market will produce “green” energy in the point “c”, where the market supply curve S crosses the demand curve D_1. The market equilibrium price P_1 will be at this point and the quantity of produced “green” energy will reach Q_1. However, if not only private but also external benefit would be evaluated, the new equilibrium price would be P_2 and the quantity of produced “green” energy would increase to Q_2, where the marginal benefit is equal to the marginal costs. Social benefit is marked in the triangle “abc”.

This theoretical approach could be implemented by the method of levelized cost. Levelized cost of energy (LCoE) is the price of energy which has to be set that at the chosen (stated) discount rate, which is equal to capital price, all discounted expenditures are equal to income, and the net present value (NPV) equals 0.

This method is very convenient, because all main criteria can be concentrated in it – net present value (equal to 0) and internal

return rate (IRR, as we determine it). The main advantage is that this indicator can be compared to the competitive price of energy in the market. In other words, the levelized cost of energy shows that the project will have, for example, 10% IRR (that is determined), if the price of this power plant electricity (or any other producer/supplier) were not lower than the price calculated by the formula

$$K_s = \sum_{i=1}^{i=n} \frac{(I_i + e_i - Z_i)}{(1+r_n)^i} \Big/ \sum_{i=1}^{i=n} \frac{G_i}{(1+r_n)^i} \qquad (1)$$

Here I_i is the capital investments; e_i is the annual operational and maintenance costs; Z_i is the external benefit of renewable energy (could be negative); r is the stated periodic discount rate; n is the years of lifetime; i is the serial number of the year; G_i is the yearly amount of produced and consumed energy and r_n is the stated discount rate (discount rate for RES can be lower than for fossil fuel).

This method is suitable for the evaluation of a wide spectrum of different options. The result obtained, for example 1 kWh levelized cost of heat, can be compared to officially confirmed price, and the feasibility of a project can be decided. The LCoE can be calculated by any of the energy development scenarios of the analysed object (apartment, house, city, district, etc.) as a composition of available capacity reconstruction, building of new power plants, micro- and mini-combined heat and power plants, usage of local and renewable energy resources and other variants. Any composition element of available scenarios influences additional costs (or inevitable loss), which are simply economically evaluated, as it is shown in the principal formula for evaluating investments by scenarios.

It must be emphasised that the main criterion is not the price of solar collectors and their installing, but also the price of a heat unit that is produced by the solar collector and effectively consumed. It is possible and even necessary to calculate how much the produced heat for the individual-family house or apartment buildings will cost with the chosen type of solar collector. The application of this method allows the estimation of all technical aspects of economical projections to the levelized cost of the heat unit. Initial calculations show that the increasing heat prices make use of solar collectors for domestic hot water preparation competitive in some cities.

Moreover, if ecological, economic and social benefit would be comprehensively evaluated in a long term period and on that basis consumers producing energy using solar energy would be given support, the demand for advanced solar technologies would increase noticeably. These facts certainly cannot determine the choice, although, in our opinion, it is necessary to be on a way of objective knowledge and education but not of the presentation of one side information. It is very important in the initial period, when the first failures of inadequate decisions can block the way to advanced technologies, that usage depends on successful examples.

3.2. Economic evaluation of the use of solar thermal energy resources by the levelized cost of energy (LCoE) method

In order to estimate the real possibilities and assumptions of solar energy use, for which higher demand for solar energy technologies could be expected, we picked a specific apartment building. It has 5 floors, 70 flats, and was built in 1978 on Saules str. in Kaunas city. The decision was made to renovate it without disconnecting of the DH system. There is a possibility to use the roof of the apartment building for solar collectors, and this system can provide the building with hot water.

Table 3
Consumption of heat in the apartment building from 2009 December to 2010 November.

Month	Quantity of consumed heat			
	For space heating (kWh)	For the preparation of hot water (kWh)	Quantity of heat, (kWh/m^2)	Total (useful) area, (m^2)
December	78150.92	21609.08	20.50	3811.96
January	124554.74	19945.26	32.67	
February	95428.62	1994.38	25.03	
March	77357.74	19792.26	20.29	
April	18538.20	19411.80	4.86	
May	0	17026.48	0	
June	0	19377.12	0	
July	0	18039.97	0	
August	0	18119.97	0	
September	0	23920.02	0	
October	45446.74	18823.26	11.92	
November	62092.00	18198.00	16.29	
Total	**501568.96**	**216257.6**	**131.58**	

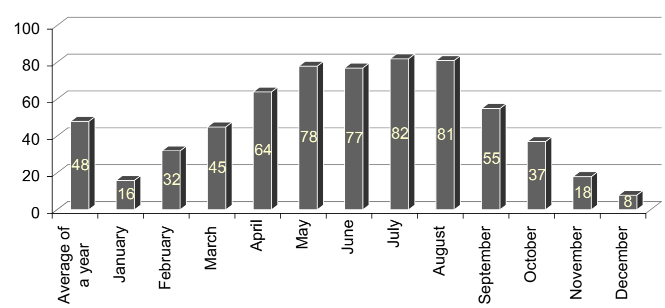

Fig. 2. Solar energy production by month, %.

Table 3 shows data from personal accounts of “Kaunas energy” from December 2009 to November 2010. The current price of heat in Kaunas is 0.09 €ct/kWh including VAT.

3.2.1. Project investments

Calculations are conducted in the frame of the project MIP-2011/007. This project enabled to purchase a calculation programme. More accurate and comprehensive information can be calculated using specialized programs, such as Polysun, T*Sol and others. Such programs have huge databases that allow to reliably estimate basic information for technical and economical calculations. Modelling is being done by evaluating the demand of hot water, working period of the flat and vacuum solar collectors in a year, as well as their efficiency. Fig. 2 shows solar energy production for each month during a year. Depending on the type of the collector, its area, and heat loss parameters the programme calculates the price of hot water made by collector, the payback period of the system, etc.

Specialised calculating programs of solar hot water evaluate theoretical possibilities of the systems, which are often different from real life conditions. We can state that the efficiency of the preparation systems of solar hot water depends not on the calculated quantity of thermal energy in collectors, but on the quantity of energy that is used actually. These quantities for the preparation of hot water by flat or vacuum collectors vary from 330 to 580 kWh/m^2 in Lithuania.

3.2.2. Operational and maintenance costs

The main advantage of the use of solar energy technologies is that exploitation is minimal. After the project implementation,

Table 4
System of solar collectors for the preparation of hot water. *Estimate—specification* (*tentative*).

No	Name of equipment and materials	Hot water prepared in the systems of solar collectors (%) of total demand (€)	
1	System of solar collectors for the preparation of hot water	**40%**	**50%**
Total (without VAT)		78,000	107,127
2	Additional materials for installation of solar collectors system	3900	5356
3	Design work	2340	3214
4	Installation, adjusting work	15,600	21,426
Total (without VAT)		99,840	137,123
VAT 21%		20,966	28,796
Total (VAT included)		12,0806	16,5919

Table 5
Summary of LCoE calculations.

Discount rates and level of subsidy 1	40% Hot water (€/kWh) 2	50% Hot water (€/kWh) 3
1. LCoE when discount rate is 4%		
1.1. Without subsidies	0.12	0.13
1.2. With a 15% subsidy	0.10	0.11
1.3. With a 50% subsidy	0.07	0.08
2. LCoE when discount rate is 7%		
2.1. Without a subsidy	0.14	0.16
2.2. With a 15% subsidy	0.12	0.14
2.3. With a 50% subsidy	0.08	0.09

expenditures of solar collectors system's operation and maintenance costs should be taken into consideration. Table 4 presents system of solar collectors for the preparation of hot water. For instance, to ensure planned heat production in the solar collectors, it is necessary to clean them from snow and dusts; expenses for hiring high-scalers can be around 290 €/year. Moreover, expenses result from changing the non-freezing heat transfer medium in the system of solar collectors every 5 years (without changing there is a risk of freezing). The requisite quantity for analysed system of propylene glycol is approximately 160 l, so the expenses would be 930 € (or 186 €/year).

The main component of operational and maintenance costs is depreciation expenses. Their value depends on investments for equipment and on the lifetime of equipment. Total operational and maintenance costs were calculated in 2 versions: (a) when a building produces 40% of heat for the preparation of hot water, the total amount is 1564 € per year and (b) 50%—2143 € per year.

Calculation of levelized costs of energy (LCoE) is carried out in these variants:

1. Residents install collector on their own funds and loans, without a subsidy.
2. Residents get 15% subsidy for investments by the Programme for the renovation/upgrading of multi-apartment buildings.
3. Hypothetically we assume that residents get 50% subsidy for investments by the Programme for the renovation/upgrading of multi-apartment buildings and environment protection programs.

Furthermore, for calculations we assume that deficient quantity of heat needed for the preparation of hot water is got from DH network at 9 €ct/kWh. Summary of LCoE calculations is given in Table 5.

The calculations showed that in comparison with natural gas, 15315 m^3 of natural gas would be saved and the emission of CO_2 would be reduced by 37238 kg (about 37 tones of CO_2). In summary, we can state that with existing conditions the use of solar energy for individual users is economically unacceptable. Nevertheless, only about 30–50% of compensations for investments could make the use of solar energy more attractive. On the other hand, it can be stated that price is not a strictly fixed value. It is a result of many different factors and can considerably vary depending on the amount of support.

4. Reasoning of incentive sources of RES demand and evaluation of the utility to national extent

From the economic viewpoint, an optimal energy system reliably supplies consumers with energy services at the lowest costs, but the rate of costs is decided by different aspects. First and foremost, the impact of pollution on the environment, the possibility to solve or at least not sharpen social problems, related to the possible growth of energy prices. Supposing RES, ensuring energy supply for future generations, are used, expenses theoretically can be discounted at a smaller discount rate that remunerates higher capital and other expenses. This, consequently, means the necessity to adequately reduce the rate of loan. In any case, different scenarios have to be compared by the aspect of reliability. Renewal of energy is a tremendous advantage, but it has to be reflected in economical evaluations, and theoretically can be evaluated by a smaller discount rate.

However, there is confusion of support characterisation and justification. The undisturbed market functioning of decision-making could be only when there is equity of all market participants. From the economic viewpoint, energy suppliers can be supported to an extent that is required for the amount of external expenses. The best support is the rise in demand, while producers and suppliers have to compete not for the quotas but for the price reduction of their production.

Administration of support schemes for the final users is more complicated than for suppliers. For example, electricity and heating companies which use RES. There are many market participants in the heating sector, therefore tax measures or any other type of regulation have to include thousands of heating and electrical systems owners in the household sector, public buildings, industry, agriculture and public services.

Promotion of RES comes in a form of subsidies for investments from various national funds or EU Structural funds in many EU countries. In Sweden, a programme of solar energy use in buildings is implemented from 2006 to the end of 2010. Subsidies were granted to the installation of RES technologies in the buildings. For the individual houses that are installing solar energy collectors, the maximum possible subsidy is 800 EUR. For the individual houses that are using geothermal energy, a subsidy is up to 3500 EUR, when the old heating system is replaced with a new one.

Some EU countries have obligations of the use of RES. For example, owners of new buildings, the area of which is more than 50 m^2, have to use RES for heating and cooling in Germany from 2009. This obligation is not only for household buildings, but also for public buildings.

Diverse combinations of RES technologies can be used in order to implement quotas. The implementation of obligation is verified by giving building certificates and a fine up to 50000 EUR can be given for failing to fulfil obligations. This is the maximum fine which is attributed to commercial buildings. Smaller fines are foreseen for private buildings.

Summing up evaluation of tendencies of solar collectors' system market growth and analysis of newly designed apartment buildings and public buildings projects, and also evaluation of tendencies of energy prices and achievements of neighbour countries, it can be stated that the use of this type of energy should increase in Lithuania in the future.

The main key to solve the problem is the use of solar and other RES in connection with important Government obligations to implement the international Kyoto Protocol and EU Directives targets. Implementation of these Directives and obligations already has concrete numeric expressions. The main problem is to create a connection between strategic decisions that are made at the national level through territorial units-regions (counties or larger regions), cities and districts till the final users.

We will discuss two important Directives that are more pressing due to fast implementation, require high costs and touch extremely painful problems of DH supply sector and households.

Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control, IPPC) tighten emission of large combustion plants limit values after 2016. These restrictions are much tighter than the existing standards: sulphur compounds (SO_2) concentration in flue gas is reducing by 2–5 times, and nitrogen oxides (NO_x) concentration – by 2–3 times; the standards for the exhaust of solid particles are also reduced. New Directive 2010/75/EU is for combustion plants, which total rated thermal input as equal to or greater than 50 MW, irrespective of the type of fuel used, and for waste incineration plants.

Implementation of IPPC Directive requires not only new burners in boilers, but also new quite expensive flue gas cleaning technologies in energy objects where fuel oil and natural gas are burning. There must be less pollutants emission from biomass combustion plants, but this is easier to achieve, because even now such plants have solid particles cleaning filters and exhausted fuel gas is usually “washed” in condensing economizers and recuperators.

The main combined heat and power plants in Vilnius, Kaunas, and Mazeikiai will have to implement the above mentioned requirements not later than 2016, because they have delayed the pollution requirements term. If existing installations of heat generation remain in these cities, then for implementation of the Directive measures of environmental protection should be installed. Total demand on investments in Lithuania's DH sector for the implementation of Directive 2010/75/EU would be 0.57 billion €, if technologies and the currently used fuel balance were not essentially changed.

Directive 2009/28/EB of the European Parliament and of the Council on the promotion of the use of energy from renewable sources laid down the mandatory overall national goals for energy from RES for Member States. The Republic of Lithuania must ensure that the share of energy from RES will be not less than 23% in gross final consumption of energy in 2020.

After the adoption of Directive in 2009, intensive debates, researches, and formation process of legal basis started. The Law on Renewable Energy of the Republic of Lithuania was enacted in 2011. It was an important and stringent result. Programme of National Renewable Energy Sources Development is currently prepared, which is set to increase the share of DH produced from RES to not less than 60% in the total balance of heat energy and to increase the share of RES for heating in households to not less than to 80% in the energy balance of consumed heat.

It is noticeable that a considerable share of RES is currently used for final consumption, especially in households. Renewable energy resources – wood, wood waste for fuel and agricultural waste – formed 69% in 2010 of fuel that is used for heating, preparation of hot water and cooking in households, which are not connected to energy supply systems of DH.

We refer to non-standard method of scenarios, which requires more comprehensive knowledge, organisation; however it also requires more financing opportunities. Depending on the scale, an individual house, a DH supply company, or, ideally, a city can form scenarios. The complex of different decisions can and must figure in a scenario, hence a biofuel and solar or geothermal energy. Moreover, energy saving to optimal level has to be in the scenario in the first place as an alternative source of energy. Therefore two main assumptions have to be taken into account: (a) development scenario, as a composition of existing capacities reconstruction, a building of new power plants, micro- and mini-co-generation plants, the use of local and RES, and other variants and (b) a scenario is constructed in a manner that no strict dividing line is done between the user of investments and a producer (supplier).

> “Although adoption of renewable energy is perceived as a means to enable delivery of emission free solutions, its penetration into the energy market has not been timely and significant enough to make material impact to the structure of the global energy system” [12].

Prospective organisational and financing form of technologies integration using structural funds are towns and regional energy programs.

> “Although the latter is a streamlined procedure imposed in jurisdictions of the development of energy infrastructures, the former still remains ambiguous and contested. A coherent **body of knowledge and practical guidance** are still missing” [13].

Methodology of municipal energy development can link National sustainable development policy to local relevant issues. Local energy development scenario starts from a clear strategic idea, which establishes links between strategic national and local goals. Municipal energy development enables the municipality to give shape to sustainable, realistic aims within a clearly defined structure. Establishing a local or major regional market rather than separate renewable energy projects could help to ensure a market of a sufficient size and enhance competition [11].

The city's progress on energy targets can be implemented just in case the analysis of current situation is organised. There must be a legal obligation to organise the implementation of indicators that distribute the development of energy at the national level through local (city, district and region) level. The negative example can be spontaneously made decisions to destroy DH networks when the price of gas increased and to reform boiler houses for the use of biofuel on a large scale. If a decision is finally made to build the terminal of liquefied natural gas, then implementation of this decision would be possible only in case of real additional demand of gas in those cities and towns that are not gasified yet. Consequently, if decisions of National strategy are not supported with appropriate city strategies, unfortunately, it is easy to be a herald of the non-feasibility of those strategies.

An example of this process organisation in Netherlands can be given. According to a Netherlands project “Climate menu” that is

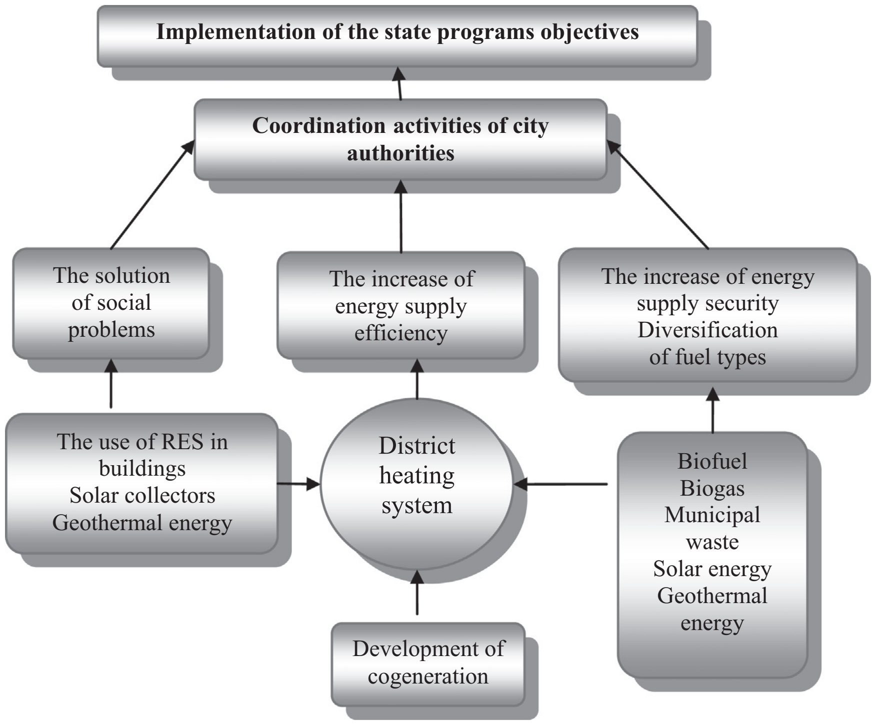

Fig. 3. Scheme of cities energy sustainable development.

implemented and financed by government, cities can choose the field of action for which exceptional attention is given with regard to the commitments of the country. Environmental policies (more information on www.climatemenu.com) are realised by cities, because the main opportunities and problems are concentrated in cities. The size of a subsidy that municipality gets depends on the quantity of residents and its size, therefore smaller municipalities cooperate for joint projects and save some money (more information on www.senternovem.nl – the energy agency of Netherlands, SenterNoverm web page).

There are 500 municipalities in Holland, and 300 of them have already used the support. Every city, depending on its size, organisation and specific problems, may select its own field of action. The support given for the realisation of the project from the government subsidies can be 50%; the municipality pays the rest of it. Every municipality chooses the areas of funding at discretion. There are three levels of objectives that show how broadly the municipality wants to develop the funding area. The funded project has to be implemented in four years.

Scientific problem is the correct evaluation of RES social benefits, which can show the advantages that are not included in investment decisions, for example, the inexhaustibility of RES and the possibility to ensure future generations of the provision of energy sources. Several RES technologies, for example, the use of solar energy, also solve environmental problems, thus it can be funded from other sources. Comprehensive knowledge is needed, and also their coordinated completeness and targeted conveyance of knowledge. Decisions are disputable, because problems are diverse.

Division of responsibilities between the central level (government, ministries) and the local level (municipalities) in relation to the areas mentioned in the municipal energy plans and strategies may be relevant. In case of Denmark, the local level should carry out municipal heat planning in combination with e.g. strategic municipal energy plan. Local subsidy and tariff schemes that accelerate connection of buildings to DH should be implemented. Also municipal utility companies as key players must be involved in implementing energy savings in the DH network [14].

Fig. 3 shows the interface between national sustainable energy goals and cities energy development objectives [11]. Cities energy advancement goals, guides of sustainable development could be implemented just in case of organising analysis of the current situation. There must be a legal obligation to organise energy sustainable development at national level distributing indicators at the local (cities, districts, regions) level. The only solution in this direction was the prospective plans of DH companies, but they are more theoretical and not related with common cities or towns, and also rural energy problems and possibilities.

DH systems have big differences in cities and in towns. The greater part of heating systems is related with comfort (DH, electricity or gas heating) in cities. Solid fuel boilers and stoves that use local energy sources dominate in rural areas and small towns. Social evaluation of energy sources is one of the most difficult economic problems, because the solution is related with indirect and still non-standard evaluation. This is energy saving and increase of energy efficiency that result in positive social effect. This also means reduction of air pollution and solves the question of expenses for social needs and health care [6]. In a recent study of the Swedish DH system [15], social costing is applied in order to evaluate the operation of a DH system based on its social cost-effectiveness.

5. Knowledge based measures to promote the use of RES

It is clear that market forces are the main stakeholders in this process. However municipalities may play a considerable role as a connecting, integrating and promoting chain between the financing organisations and energy consumers. “Formulation of national sustainable energy strategies must emerge from interactive and inclusive processes of social dialogue and reflection. The processes

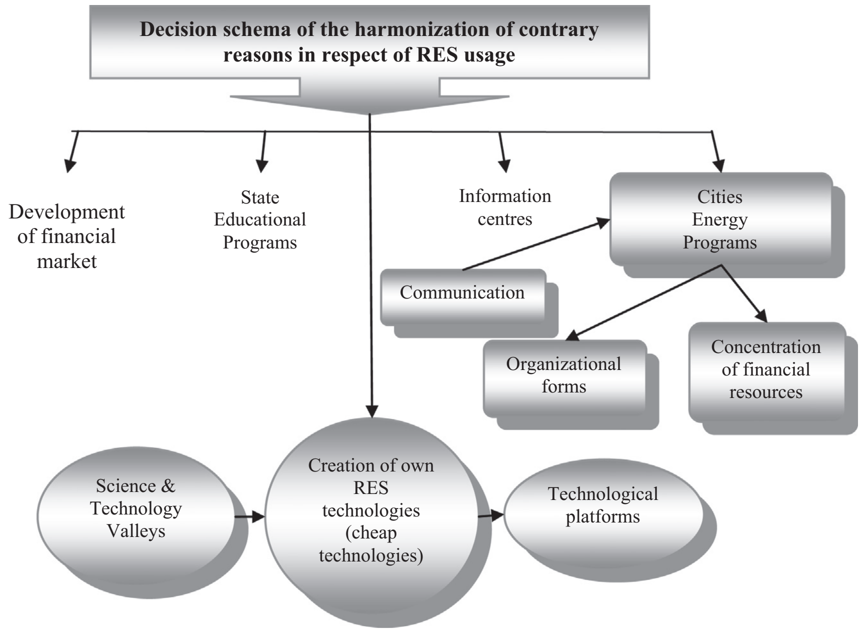

Fig. 4. Decisions scheme of adjusting different motives with regard to RES.

are guided by orientation knowledge of justification arguments used by different stakeholders" [16].

Talking about perspectives of the use of solar energy, it is evident that the main market is on the user's side. The most important problem, determining the slow absorption process of solar energy on the part of the consumer, is the lack of knowledge and organisation, deterrent amount of investments, and especially the differences between energy suppliers and users in the heating sector.

It has to be noted that technology development is noticeably one step ahead of the general level of society education and its susceptibility to innovation, in economic terms, the demand of new technologies, innovative forms of financing and forms of managerial organisation. For example, the sustainable development of the heating sector is an integral part of smart grids that are based on the idea of developing information and communication technologies. It is the reorganisation of the electricity and heating system, based on technologies and innovations, the main idea of which is to develop sustainable cooperation between producer and consumer, giving users more opportunities to be in the electricity and heating market. Smart grids development would promote the use of RES and also promote not only the liberalisation of the electricity, but also of the heating market. Reorganised system of heating market would stimulate the efficiency of consumption and production of electricity and heating, would decrease the negative influence to the environment, would motivate the creation of new workplaces and would reduce the prices of energy.

A new educological conception is needed, directed to the development of mentality of the society for sustainable development. Moreover, the concept of sustainable development determines the boundaries and absolute limits, and restrictions placed on the influence of current technologies on environmental sources and the necessity to absorb the effects of human activity [17].

The task of RES evaluation makes us deepen our knowledge and answer more than one question on the economic theory. In the presence of global risks of climate changes a question arises, what is the essence of technical progress in the presence of exhausting energy sources and how do the economical theory and policies have to be transformed? Because of the fluctuation of natural gas prices, the development of economics becomes more and more problematic and difficult to forecast, and the combustion of energy sources is certainly accepted as an incentive of the global climate changes. Therefore, the necessity of the use of RES, as widely as possible, is undoubted.

In this context, there emerges the solidity of a knowledge based economy concept. One of the main science roles is to give information, which enables the formation of the development policy in a decision making process. It is necessary to essentially improve scientific perception, based on scientific researches, and to raise the scientific competence of a country.

The concept of knowledge based economy noticeably expands the general concept of development and adequately raises new goals and assumptions that are defined in Fig. 4.

Only complex knowledge and its appropriate conveyance and the system of education can form an economic basis for the successful development of progressive technologies. However energy user's knowledge about the benefits of RES is only fragments compared to the entirety of knowledge that creates demand based on the social utility. Therefore investments for the dissemination of knowledge can be approached as components promoting technical progress.

Consequently, the greatest benefit can provide knowledge, formation of reliable and practically proved knowledge, the dispersion of knowledge and promotion of technology design.

6. Conclusions

1. The extent and directions of use of energy resources can depend on decisions and liabilities of governmental programs. Thereby further questions about funding are redirected, especially the use of Structural Funds, feed-in tariffs and other questions. The planned indicators for the implementation of Directives are not less than 60% of use of RES in the DH system and not less than 80% in households. The main direction, of course, is the use of biofuel in current situation.
2. Enormous potential of the use of solar energy is in the sector of apartment buildings. This potential can be realised by renovating the apartment buildings and modernising the heating sector. The use of solar collector for the preparation of hot water in apartment buildings is currently the most perspective

direction and its potential is evaluated by 40% of heat amount which is required for hot water.

3. Economic competitiveness is evaluated by a levelized cost of energy method. It can be stated that in the frame of the apartment buildings' Programme, when modernising the heat sector in many cities, the installation of solar energy for the preparation of hot water would be competitive even without additional support. Of course, the main assumption is needed – organisation. It is necessary to be at the cutting edge of conveying objective knowledge and education, not the one-sided information. It is very important, in the initial period, when the first failures of the inappropriate decisions can block the way for advanced technologies, that receptivity depends on successful examples.
4. The use of solar energy also solves the environmental problems, thus it can be additionally funded from other sources. Additional support should be based on the fact that the use of solar energy would make a rather significant contribution to deal with the implementation of Directives issues. It is evident that the particularly relevant support would be subsidies for investments and soft loans. The amount of a support has to be based on the external benefit that would be adequate for utility.
5. Talking about the perspectives of the use of solar energy, it is evident that the main market is decided by the consumer. The most important problem, determining the slow absorption process of solar energy on the part of the consumer, is the lack of knowledge and organisation, deterrent amount of investments, and especially the differences between energy suppliers and users in the heating sector.

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